The Interaction between Braille and Tactile Pictures for Deeper Understanding

A report from a Swedish research project in progress by

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Abstract

In the project "Reading by hands – measuring techniques, theory and empirical analysis" movements of hands and fingers are registered on line in reading of Braille and tactile pictures. One focus in the analysis is on how the reader operates with the apprehended information from Braille and the tactile picture on a cognitive level.

Introduction

As educators for Braille reading students we have, so far, based our knowledge of how to teach efficient reading by touch on research from important researchers like Nolan and Kederis (1969) and Lowenfeld, Abel and Hatlen (1969), among others. Sally Mangold (Mangold 1982) and Diane Wormsley (Wormsley, D.P. & D´Andrea, F.M. 1997)) have, as researchers, also turned their results into practise and given us many tools for teaching. The picture of an efficient Braille reader is impressed into us all —efficient Braille readers

- use two hands,
- use more than just the index finger on each hand,
- have a reading flow with few return sweeps over the line,
- hardly ever rub their letters

and last but not least important

- are avid and motivated to read a lot.

The slow reading rate in Braille reading in comparison to print reading has been a constant dilemma in our education, particularly evident nowadays when more Braille readers are studying together with print readers in the classroom and are supposed to solve the same task in the same time. Hence we need methods for training rapid reading. But we also need more knowledge about the reading process in Braille in comparison to print for developing these methods. There is great knowledge about the reading process in print both from a

psycholinguistic and a perceptual perspective. Eye movements have been studied objectively on line, which has given us pictures on the computer screen of how an efficient print reader moves over the line and the page. In comparison with Braille reading there is an important difference, since the eye is reading when it fixates letters but the fingers have to move to perceive the Braille letters. “Movement is as indispensable to touch as light is to vision” is an expression from 1925 by Lester E. Kreuger, a psychologist at Ohio State City University, when he referred to David Katz´s theories about tactual perception. Another difference discussed among researchers dealing with Braille is the space of the perceptual “window” compared to print reading.

In visual perception, the so-called foveal vision is constrained to just a little more than one degree of the visual field. The further away from the focus, the so-called parafoveal vision, the less distinct the appearance of visual stimuli. Still, parafoveal vision plays an important role in both reading and image-viewing. For the reading eye, it is sufficient to spend only one fixation on a word of up to 7 letters in order to read the word. At the same time, the parafoveal vision allows the reader to pre-inform himself about words that are around 15 letters further away in the direction of reading (Rayner 1995). How many characters a Braille reader perceives at a time we do not know exactly. Nolan and Kederis (1969) established that the perceptual unit in Braille was only one character at a time and that fluent reading was performed letter by letter. But Susanna Millar (1997), a British researcher, states that semantic and phonological processes contribute early in Braille reading for three characters in close connection to the reader’s cognitive and verbal ability, a so called “word superiority effect”. When comparing visual and tactile reading, questions emerge to determine whether there are functional similarities to foveal and parafoveal vision in tactile reading. How many fingers can simultaneously be involved in reading? When several fingers are active, is the index finger dedicated to the attentional focus and the rightmost fingers free to pre-inform the reader about information within close reach? These are questions on the perceptual level raised previously.

There are real similarities in the reading processes in print and Braille particularly if we look at lexical and semantic cues, according to Millar. Her conclusion is that reading is more than only perception. Reading Braille is a combination of perception and the ability to use context both on a linguistic and cognitive level. During Braille reading the hands cooperate to get information about both verbal and spatial aspects. There is no best hand or finger for efficient

reading, according to Millar. Their functions vary due to the target to solve. Other researchers have found the same; the reading technique and reading rate in Braille depend on the kind of reading tasks (Knowlton and Wetzel 1996).

Even if we have had a lot of serious research into different aspects in Braille reading, there are still unanswered questions about the differences in reading by sight and by touch on a basic research level. When it comes to tactile pictures we find the same. Is the attention distributed in different ways on the fingers depending on whether the task is picture-viewing or Braille text reading? How large is the individual variation with respect to the behavioral characteristics described above? Which aspects of their own reading or picture-viewing behavior are the tactile readers themselves aware of? How do they describe these aspects in their running think-aloud comments or in the post-reading and post-picture-viewing debriefing sessions? A closer study of these phenomena is of great interest to pedagogical applications. In effect, the community of Braille readers has not yet been able to profit from an important source of knowledge about their own reading.

In earlier research we can read about different objective techniques to measure decoding of the Braille character to find out what makes the code hard or easy to identify (Schiff & Foulke 1982). Finger and hand movements have been studied with the help of video cameras, and through subjective observation techniques the readers' hands have been described and interpreted. The lack, so far, of a system equivalent to the eye-tracker but tailored to the study of tactile reading has severely hampered the process of integrating the study of tactile reading with the modern psycholinguistic and cognitive paradigm. However, new computer technology opens possibilities for measuring and testing unanswered hypotheses. The secrets of Braille reading will hopefully be objectively disclosed on the perceptual, linguistic and cognitive levels. In the light of the described basic research questions, a project has been initiated by Professor of Linguistics Sven Strömqvist. He is also the head of the Swedish Braille Committee.

Disposition of the presentation

To begin with, a just-finished feasibility project will be presented in which the reading technique in reading prose was registered on-line and the finger movements of five experienced Braille readers were analysed (Breidegard, Fellenius, Jönsson and Strömqvist, 2007). Next another on-line registration technique will be described that has been used in the

current project-in-progress in the same research. Among other things, we are now looking for the interactive processes between Braille reading and the tactile picture to gain deeper understanding. The analysis is in its early stages, but our findings will perhaps start a discussion at the end of this session. Three cases are chosen for this presentation from a group of twenty-eight Braille readers of different ages to illustrate how we have started to analyse the data. Before the presentations of the techniques and the cases, we would like to present some theories and thoughts about pictures in general and the process of decoding tactile pictures specifically.

Tactile pictures – a theoretical background

The use of pictures in education has a long history, both in regular schools and in schools for the blind (Eriksson 1998; 2000). The enthusiasm for all kinds of pictures rests on the belief that they benefit comprehension and learning and foster insight (Tversky 2002). The enthusiasm for pictures has been shared by teachers who were involved in education of blind children from the late 18th century until the mid 20th century (Eriksson 1998). Tactile images provide an additional way of representing information. Before the introduction of Braille, oral information dominated in teaching, and tactile pictures not only promote insight, they were used by the teacher to control the blind pupil's mental image since it is possible to externalise internal knowledge in pictures (Eriksson 1998).

A great deal of our knowledge has been mediated via text and images. There is a tendency, nowadays, for people to seek information about places before visiting them; thus we go from information to reality, rather than first visiting a place and than searching for information. This is a change in behaviour due to the availability of information via the Internet. But still we analyse and teach in a tradition with its heritage in the Enlightenment, an epistemology that goes from the real world to pictures, often via models. That is an epistemology presuming an accurate connection between the representation and the real thing. This pedagogical tradition has been especially strong in the education of blind children. Therefore it is necessary to examine the effects of this approach to knowledge, especially in relation to tactile representations.

Much of sighted children and adults´ knowledge is based on information from visual representations. Pictures show things that would otherwise need words to describe, in particular faces, maps and systems. Other functions of pictures are to depict space to organise

information and to facilitate memory and inference. However, tactile images can never substitute for a description; they need an accompanying text (Eriksson 1993).
We attach great importance to visual representations, but paradoxically there is an equally great lack of training within the field, for sighted and blind children alike. People use symbols to communicate; these symbols may be visual, like a picture, a gesture, or a movement in a dance or theatre performance, or sound-based. They could also be tactile. In many ways, these symbols constitute how we think, talk and act. Consequently, it is important for children and young people to be skilled in using and interpreting symbols. They are, after all, embodied in our culture, and hence in our personality.

What is a picture?

Pictures can be divided into two kinds: those that portray things that are essentially visuo-spatial, and those that represent things that are not inherently visual. Maps, molecules and architectural drawings belong to the first group; organisation charts, flow diagrams and graphs belong to the second group. Outline pictures explored by touch follow the same principles as outline pictures examined by eye; the line stands for surface boundaries (Kennedy 2000:67). Furthermore, results indicate that blind people are able to use mental representations to analyse visuo-spatial patterns, although their performance could be less effective in complex tasks and the process could take longer (Cornold and Vecchi, 2000:148). Consequently, graphics displaying visou-spatial phenomena and those portraying objects can be represented in tactile pictures. Mental images are created from linguistic, visual and haptic information and play a crucial role in our understanding of objects and phenomena, and for orientation. However, sighted and blind people have mental images alike, since mental images are generated by integration between linguistic, haptic and visual information. Blind people compensate for the lack of sight by using touch (Klintberg 2007). We suggest that tactile pictures help blind people to create mental images just as visual pictures stimulate mental images for the sighted.

Tactile pictures are often used in education for children who are blind or in providing information about the appearance of things. Information is "something that describes an ordered reality and has some knowable, or at least idealized, isomorphic relation to that reality" (Devin 1999:36). Furthermore, "information is a tool designed by human beings to make sense of a reality assumed to be both chaotic and orderly" (Devin 1999:39). Tactile pictures are a tool for information that can be used to describe reality in a tangible way.

Pictures are often necessary to describe concepts that not are verbal. In contrast to language, pictures are symbols.

It is hard to imagine a language without proper names (Bloom 2000:145). When we name an object, the reference is to a particular item. Children learn the meaning of words by grasping the underlying conditions. An example of such a condition is the category to which the words belong; a category could be more or less specific. We can talk about dogs in general or about a specific race, but we can also refer to a particular dog. In all cases the dog belongs to the category dogs, which belongs to mammals. Categorisation is fundamental for the discussion of concepts. We often use categorisation to define a concept; it is a way to get an understanding of it. To be able to communicate, terms are necessary. We need general terms for the purpose of generalisation. Generalisation is essential for inductive learning (Bloom 2000:147), and for communication. There is, however, a difference between real categories and abstract ones; the latter is based on conventions and mental images, while the former is based on objects that share the same properties. It is possible to deduce unobserved properties once you know which basic-level category something belongs to, and it is also relatively easy to make categorisations from that (Marphy and Lassaline, 1997). By looking at an unfamiliar animal at a zoo you can, from previous experience of mammals and invertebrate animals, deduce if it is a mammal or not. The next step is to decide to which family it belongs, cats, bears or hoofed animals. To define the animal one must, however, have detailed information, but by deduction it is possible to get an idea about the animal. We find the same process in interpretation of pictures (Eriksson 1997).

Evidence suggests that children rely on perceptual properties, and specifically shape, when generalising words. "In particular, when given a new count noun that refers to a rigid object, children will typically extend that noun to other rigid objects of the same shape, not those of the same size, colour or texture [...] we can call this the *shape bias*" (Bloom 200:155). There exist two theories about the nature of bias, *brute-shape theory* and *shape-as-cue-theory* (Ibid). When children meet novel words they tend to refer to a familiar object with a similar shape. This is called *brute-shape theory*. The interpretation of shape is context-bound. If a child is shown a picture of a cat and one of a car, and is asked to point out the graphic showing the dog, they will point at the cat. It is not necessary for them to know that the picture displays a cat, since it is more likely that the cat rather than the car represents a dog. We are often looking for what we are expecting to see, not only in pictures, but in the environment.

Children can additionally have the idea that the shape of an object is highly related to the kind of objects it belongs to (Ibid.). That is called *shape-as-cue-theory*. This alternative theory suggests that children have the idea that the shape of an object is highly related to the kind it belongs to (Ibid.). The first example suggests that shape bias is limited to words; shape as a cue for naming, while the second example suggests that shape is used for referring to the basis of a kind, using it to refer to entities that have different shapes.

Even though it is not possible to assert something in a picture, visual representation often affects our opinions. The appearance of images is not only a result of their function, but also a consequence of ideas about how specific object should be represented. That often has consequences for the design of tactile pictures. It is often hard for designers of tactile images to liberate themselves from visual conventions and focus on the conditions of tactile perception (Eriksson 1997). What could be displayed in a tactile picture is not strikingly different from visual pictures. It is more a question of *how* the picture should be produced to fit the tactile perception. Most pictures can be transferred to tactile images, and in a tactile image practically anything can be illustrated. A tactile image is an image scanned with the fingertips: it is executed in relief. A relief can assume many different forms and can be produced by several different techniques. But simply producing images in a relief is not enough: for tactile interpretation, they have to have a plain and simple form (Eriksson 1997; 1999).

In a study of a blind girl reading a tactile picture book together with her mother (Domincovic, Eriksson and Fellenius 2006), she is exposed by pictures to a garret, with a lot of things – a bicycle wheel, bags, broom, an umbrella, shoes and a bottle. When the mother has finished reading the accompanying text, the girl starts to investigate the picture page. She begins with the wheel, and spontaneously interprets it as a tunnel. For those who do not have the knowledge of the spatial training for blind children, it seems odd to interpret the wheel as a tunnel. But for the girl this is very logical, since she has the experience from pre-school of crawling in a circular tunnel in the playroom, and she immediately recognises the shape of the entrance. Her experiences of bicycle wheels are scarcer. But when the mother told her that it is a bicycle wheel she could recognise the object as a wheel. The other picture element that she paid attention to was the broom. She first discovered the brush and then the broomstick, and spontaneously exclaimed "broom."

How come she could recognise and identify elements in the picture as representations of objects? First of all, the objects are represented in such a way that the perceptual and the physical shapes are very similar, which of course is paramount for recognising a tactile representation as a representation of a familiar object. Secondly, she used her experience and, we assume, organised her thinking into different domains or categories. Categories can be defined according to their properties (Gärdenfors 2000:100). The property the girl recognized was the circular shape.

1. When she first discovered the wheel, she thought of it as a circular shape.
2. The circular shape made it distinct from the umbrella to the left (which she could not identify).
3. The circular shape of the bicycle wheel reminded the girl of the entrance to the tunnel she had experienced; the tunnel resembled the element in the picture.
4. She put the object into the category of circular shapes.

The theory about properties is comparable to the theories about the nature of bias discussed by Bloom (2000:155), specially the brute-shape theory. And we presume that she went through more or less the same processes when she identified the wheel and other objects in the book.

When talking about visual images, we have to be aware of the interplay between categories and singular representations. We need to use this interplay in order to create images of objects depicted in such a way that they simultaneously can represent a specific object and function as a representation of a specific category. From the very beginning, children with visual impairment (blindness) have to learn what characterizes different categories of objects, animals and human beings. Otherwise they will not be able to identify specific objects by touch.

Without this knowledge it is not possible to discriminate either real objects via touch or tactile representations. This is what makes images unique, and in many cases essential, not only for the sighted but for the blind, since it is possible to show and clarify things in pictures that would otherwise be incomprehensible. Illustrations are, therefore, frequently used in scientific texts to explain or to prove a result, both in Braille books and regular ink-prints. Visual representations are, however, differently perceived by blind people and by the sighted. While it is important, in many ways, to avoid stereotypes in visual representations, they are to be recommended in tactile pictures.

Since most concepts are not verbal, visual representations are necessary for the blind as well as for the sighted if they are to obtain a full understanding of their surroundings. Interestingly, blind children today do not get the same training in how to interpret tactile representations as they used to during the first decades of the last century. Analogically, there is no training in regular schools, nowadays, in how to read illustrations in schoolbooks. It is taken for granted that children and young people today master the language of images, and have no need for guidance or training. When illustrations were first introduced in teaching in regular schools around 1880, it was common that the preface to the schoolbooks would include directions to the teacher about how to use the illustrations in teaching and about how to introduce the pictures to the pupils. In addition, the authors gave clear instructions and descriptions of the pictures in the text, to facilitate the interpretation of the message by the pupils (Eriksson, 2001:87).

Members of the Swedish interdisciplinary team - a presentation

The research group of the project is an interdisciplinary team and consists of Dr Björn Breidegard (programmer and expert on the development of technical aids for the functionally disabled, Division of Rehabilitation Engineering Research, Department of Design Sciences, Lund University), Dr Yvonne Eriksson (expert on tactile pictures, Department of Art History and Visual Studies, Göteborg University/Mälardalen University), Dr Kerstin Fellenius (expert on pedagogy for the visually impaired, Department of Human Development, Learning and Special Education, Stockholm Institute of Education), Dr Kenneth Holmqvist (eye-tracking expert, Centre for Language and Literature, Lund University), Professor Bodil Jönsson (Division of Rehabilitation Engineering Research, Department of Design Sciences, Lund University) and Professor Sven Strömqvist (project leader, Department of Linguistics and Phonetics, Lund University, Sweden).

The feasibility project – Phase one in 2003 - 2004

In the feasibility project called "Reading by hands - measuring techniques, theory and empirical analyses" an automatic finger-tracking system (AFTS) was developed.

The aim of the feasibility project was two-fold: to design a well functioning automatic finger-tracking system and to demonstrate its usefulness for analysis purposes in a small-scale pilot project with blind research persons. The technical goal of the feasibility project was to design an automatic computerized system for online recording of finger movements during Braille

reading or tactile image viewing, and an interactive program for the analysis of the recordings.
Seven adult blind Swedes, all experienced Braille readers, participated in the pilot study. Their reading behaviour was video recorded and the recordings were fed to the Automatic Finger-Tracking System (AFTS) (Breidegard, Fellenius, Jönsson and Strömqvist 2007).

The recording equipment of the lab combines a registration table with computer hardware and software. The registration table consists of a standard vertically adjustable table, modified with a rectangular cut-out covered with a solid transparent glass plate. The specially prepared semi-transparent reading material was placed on the glass plate, and the users could sit comfortably, reading the material in their normal way using both hands. A camera was placed under the table, directed upwards through the glass plate and registering the fingers and fingertips through the reading material from below. A second camera was placed on the table for the purpose of registering the hands from an angle above. The two cameras and the microphone were connected to a standard Windows PC computer equipped with extra hard disk space to store the large amount of recorded data. Recording software was designed to combine the two video streams and the audio stream for storage as one audio-video file on the hard disk (Breidegard et al. 2007).

Data were collected from reading different types of text in Braille, such as narrative text, expository text, and scientific text; viewing/exploration of tactile pictures. The reading/picture-viewing tasks were combined with interviews with the research persons -- about their personal history as well as about the tasks just performed. The combination of online-data from the reading activities and interview data with the readers' reflexions about their own reading strategies offers a unique window on tactile reading. It makes it possible to analyse the complex structure of the online behaviour of reading and picture-viewing as well as the meta-cognitive awareness in the readers (Ibid.).

For the analyses we selected the most homogeneous participants, bearing in mind their Braille reading experiences, i.e. the five persons who only had Braille as their reading medium and used reading and writing every day in their daily work. There were three women and two men. Even in this small group the variation of reading techniques was remarkable. The statement from Susanna Millar that each Braille reader has his own reading style was verified. We described their reading techniques in prose from the categories used by some Belgian

researchers (Bertelson, Mousty and D´Alimonte 1985), as conjoint, disjoint and mixed exploration. Conjoint means that both index fingers proceed along the line and more or less even during line shifting. On the contrary, a disjoint technique describes that the two hands explore different part of the line, e.g. one hand reads while the other navigates to the next line. The most common style is a mixed pattern when the left hand starts reading when the right hand is finishing the previous line, and then the hands meet and read together in the middle of the line before they separate again (Breidegard et al. 2007).

In our pilot group we found three mixed readers, one disjoint and one who used only her right hand. The one-handed reader used her index and middle finger very close together over the whole line and in line shifting. The left hand was placed in the margin without any movements. Two of the mixed readers, both men, told us that they preferred to read with their left hand. This fact became also obvious when they tried to read with only one hand at a time. The reading rate was almost twice that with their left hand than with their right. The pilot study indicated that a more conjoint reading style in a mixed reading pattern could be an efficient reading technique, which means that two hands work together in decoding in the middle of the line for a rather long time on condition that only one hand navigates faster to the next line in line shifting. The feedback and the discussion with the readers about preferences in reading to make them aware of advantages and disadvantages in the personal style were important. With this automatic finger tracking technique we could not exactly register how many fingers were involved in the perception of the letters at a time, but we got a good picture of the movements of the index fingers, the line shifting technique and the reading rate when reading with different hands and fingers (Ibid.).

”The tactile reading ” – Phase two in 2006 – 2008

The new project in progress called “The tactile reading” is launched in the Centre for Languages and Literature at Lund University (www.sol.lu.se) – integrated in a new multidisciplinary laboratory environment for the study of languages, culture, communication and cognition. By thus making the tactile lab permanent, the lab will also be much more accessible to tactile readers, who can visit the lab and make recordings on a running basis. Our present focus of analysis includes Braille reading, the interaction between Braille and tactile pictures, comparisons of tactile reading behaviour in children and adults and the contrastive study of tactile and visual reading. The experts of the different disciplines represented in the research team will perform analysis of the collected data. The knowledge

that emerges from this type of study is expected to be of great importance to the design and production of tactile material as well as to the design of pedagogical practices.
In the second phase we have tried another registration technique, a so-called motion tracker. This technique has been used in earlier linguistic research to register gestures, for instance when people are talking. The motion tracker used has up to 8 infrared cameras that film the measurement area from different angles. Subjects were given small markers on their fingers reflecting infrared light emitted from lamps inside the cameras. When seeing these markers from different positions, the system is able to create a 3D measurement of the movement of each reflector. Markers were attached on each fingernail on both hands of the subject except the thumbs, and also on the knuckles, in order to register the movements of the height of the hand during reading. The data have then been processed into an interactive program and visualized for analysis. The collected data include finger and hand movements in reading different tactile materials in Braille, prose and expository texts, words in columns with and without meaning, and tactile pictures with and without Braille text for comparing the reader's behaviour in relation to different tasks. The phase of analysis is in its beginning stage and there are no final results to report.

Twenty-eight Braille readers have participated so far and been registered, eighteen adults and ten students. There are seven subjects with some residual vision (<0.05; 3/60; 20/400 except one boy of 0.1; 6/60/; 20/200), but all have Braille as their main reading medium. Subjects with some vision conducted the tasks blindfolded. All but three subjects started their Braille reading in first grade. The reading session started with a short interview about the subject's own idea of his/her reading techniques and experiences of tactile pictures. They also performed a short working-memory test before starting the reading of a fictional prose selection with a well-known content in order to categorize the mode of reading and the reading rate aloud and silently. Then they went through the rest of the reading and picture targets. To illustrate the techniques and how the interactive program for analysis works, we have chosen three subjects for demonstration, two students and one elderly woman, and their solutions of three tasks.

Subject A is a girl student, 18 years old, studying humanities and art programs at college level. She is blind from birth and learnt Braille in the ordinary school, without any specialized teacher in Braille, when she was seven. She reads Braille in her studies both on paper and Braille display. She has a mixed reading mode where her two hands read together in the

middle of the line (conjoint 2/4 of the line length). The girl is not particularly aware of her reading mode but thinks that her right hand dominates in reading, but that both index fingers are important in decoding. She assumes that the remaining fingers have no function. The left hand is checking line shift. In the working memory test she performed adequately and is a moderate Braille reader in relation to her age considering reading rate (aloud 81 w/m; silent 75 w/m). In the interview we were told that she likes tactile pictures but does not find them easy to understand. Mostly they appear in math, seldom somewhere else. She would appreciate having the same pictures in microcapsule paper as her classmates do in order to be involved.

Subject B is a woman, 69 years old and blind from birth. She has learnt Braille in a special school when she was seven. While reading she only uses her right hand and her opinion is that her left hand has no function at all in reading. According to her experiences she had never been taught to use both hands. The most dominant finger is the right index finger and she assumes that the rest of the right hand fingers perhaps help her to keep the line and "run" forward. She has a very good working memory related to her age and also a good reading rate in her one-handed mode (aloud 123 w/m aloud; silent 143 w/m). She gets in touch with tactile pictures very seldom but remembers her work with tactile maps during her school time and has also sometimes met tactile pictures when reading for her grandchildren.

Subject C is a boy, 18 years old, studying science and math on college level. He has some vision (0.03 on both eyes from birth) and uses his vision together with magnifying programs to read news etc. on the Internet. Braille on paper takes up only 5 to 10 percent of his reading time. He is reading electronic textbooks via synthetic speech and talking books. He has been taught Braille since first grade and thinks he needs Braille when learning something new, e.g. languages and spelling. His reading mode, according to himself, is using both hands equally, and both index fingers and middle fingers are active in decoding. In the test situation he demonstrates a conjoint exploration, in agreement with his own description.
With this reading mode he is a rather slow reader in Braille in relation to his age (aloud 52 w/m; silent 47 w/p). He loves tactile pictures and thinks they are indispensable in math, physics and chemistry. He meets tactile pictures every week in his studies and is used to maps.

The second task to solve was to interpret a tactile picture with no text information in it. The tactile picture shows a face in a very simplified way and includes only the significant elements for a face: eyes, eyebrows, nose and mouth. The figure is made with short hair and the ears are therefore visible and touchable. The subjects were asked to identify the motif of the tactile picture, and at the same time think aloud.

Subject A: She is using both hands, starting at the top of the head and touching the outline of the face symmetrically. She continues with parallel touch for detail in the face, which is the nose. Henceforth she alternates between symmetrical and parallel touch, but she investigates some details with only one hand. She finishes by following the outline of the face with her right hand.
Subject B: She starts from the left side by parallel touch, close to the ear. Then she continues with asymmetrical touch. She starts with the detail of the face, such as eyes, nose and mouth. The outline of the face she grasps via symmetrical touch.
Subject C: He is constantly working with symmetrical touch. He starts with the eyes and then explores the size of the sheet. He goes back to the eyes and continues with the eyebrows. After that he follows the outlines of the face symmetrically. Then he goes on with other details and ends with the eyes.
Subject A and C are using both hands, symmetrically and in parallel, while interpreting the tactile picture. This could be explained by the fact that they are two-handed Braille readers. Another explanation could be that the strategy depends on the character of the picture, which is a symmetrical shape. Subject B, on the other hand, is a one-handed Braille reader. To be able to interpret the picture she uses both hands but asymmetrically, which could perhaps be explained by her not being used to read with her two hands simultaneously.

The third reading situation we would like to present is a typical school task for third grade including a tactile map followed by multiple choice answers in Braille. The tactile map in the test was transformed from the map in the reading test for the sighted. In our test the fictive map of the island was made considering tactile perception (Eriksson, Jansson and Strucel 2002). The map was made in microcapsule paper; it has a headline with the following text: "The Island. Use this map to answer the questions." In the upper left a compass card was represented by a cross with arrows showing the four cardinal points. The island is surrounded by a texture used for representing water. A distinct contour line defines the shape of the island, and different texture is used to symbolise different areas of the island: a park, a wood,

a lake and a marsh. To illustrate the town on the island, a squared pattern is drawn. A farm is illustrated with a single square. The different parts of the island were connected by three distinct roads. Two of the roads are named and indicated in Braille. For the registration all pages had to be fastened on the table, which resulted in a rather unnatural reading position. The map was placed at the top of the table, and the questions in Braille in two columns were located under the island.

There are four tasks to be solved. In the first question the reader is requested to find a point of the compass: *What is located south of the farm?* Four alternatives follow. The second question contains a distance concept: *What is nearest the marsh?* Four alternatives are given.
In the third question you must follow an instruction to find the place among four alternatives: *1. Start at the farm. 2. Walk in northern direction to the first road cross. 3. Turn to the left. 4. Walk to the first corner. Where are you now?* In the last task the knowledge about the cardinal points is tested: *If you would like to walk from the city to the park you will walk*

- *northwards*
- *southwards*
- *eastwards*
- *westwards*

The three subjects started by exploring the map. However, the way the subjects solved the whole task was strikingly different. Subject A spent most time in exploring the map before starting with the questions, in fact half of the time. For exploration of the map subject B used 1/3 of the total used time for solving the whole task. Subject C used less time for the initial exploration of the map, ca 17% of the time it took him to solve the whole task. Despite the three subjects' strategies they spent nearly the same amount of time answering the whole target.

Subject A read the first two questions (and the last one) and its alternative answers using both hands. To solve the tasks she searched the map by alternating both hands. While following the instructions in question three, she read the Braille text with her left hand, and at the same time she read the map with her right hand. Subject B read questions one and two with her right hand and answered the questions without reading the alternative answers. She also read the map with her right hand. Subject B was unfamiliar with questions with alternative answers, which caused her some problems. After further instructions she started to read the alternative answers. To follow the instructions in question three she used her left hand as a

referent and a marker while reading the instructions with her right hand. Subject C started to read the questions and the alternatives, then he re-read the questions, and after that he started to read the map using both hands. Apparently his conjoint Braille reading strategy is used also when he is reading the map.

After finishing the task the subjects where asked to describe the island. Their descriptions indicate that they have a deep understanding of the island's shape, the location of the different places on the island and the directions of the roads.

Conclusions

We suggest that tactile pictures give a better understanding of words and concepts. The analyses of the collected data in this project support this hypothesis. The study espouses that it is possible to identify tactile pictures of familiar objects without any instructions or Braille. It is also clear that tactile pictures help blind people to create a mental image in the same way as visual pictures create mental images for the sighted. Therefore it is important to introduce tactile pictures in early childhood for prospective Braille readers.

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